Nordic energy innovation systems - patterns of need integration and co-operation

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Publication date:
2008

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NORIA -energy policy seminar, Oslo, Dec. 2008

Project by:

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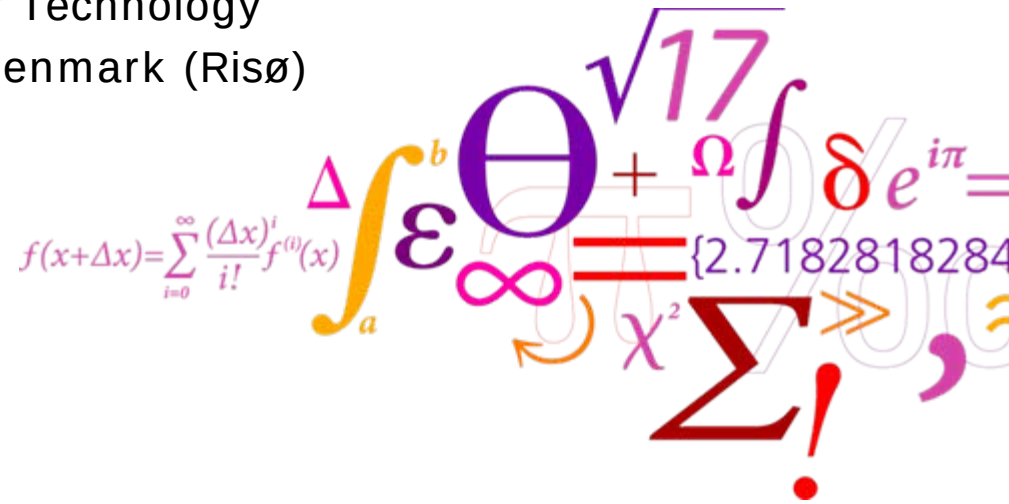


DTU Management Engineering
Department of Management Engineering

Background: Why is it relevant?

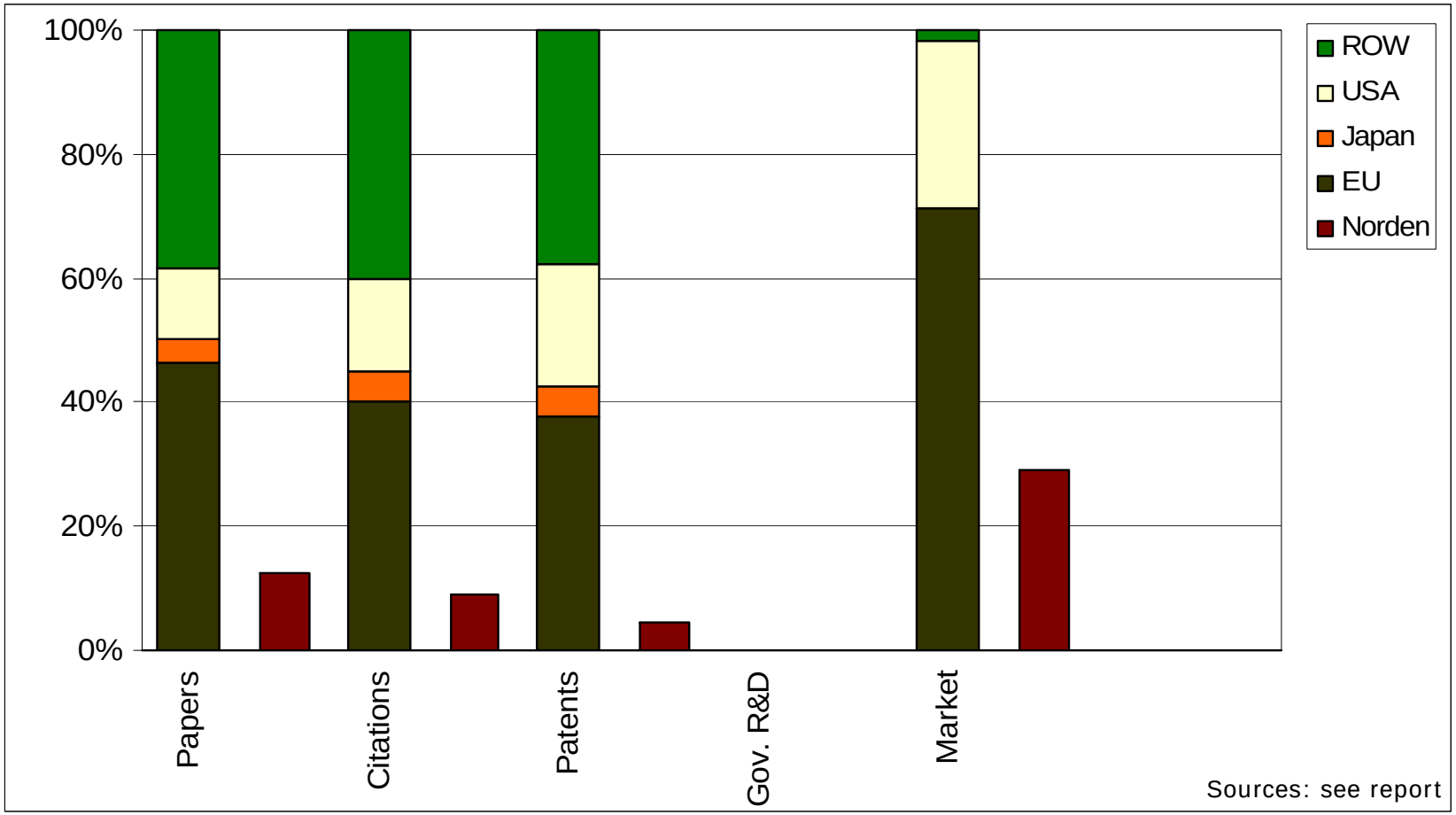
- Innovation perspective is increasingly relevant for the energy area
  - Privatisation and globalisation tendencies
  - Understanding change and development as
    - Interplay between private and public actors
      (not top-down planning)
    - Dynamics of change seen on a systemic level
      (not only one actor group or one type of activities)

- Major industry area - huge economy and activity area

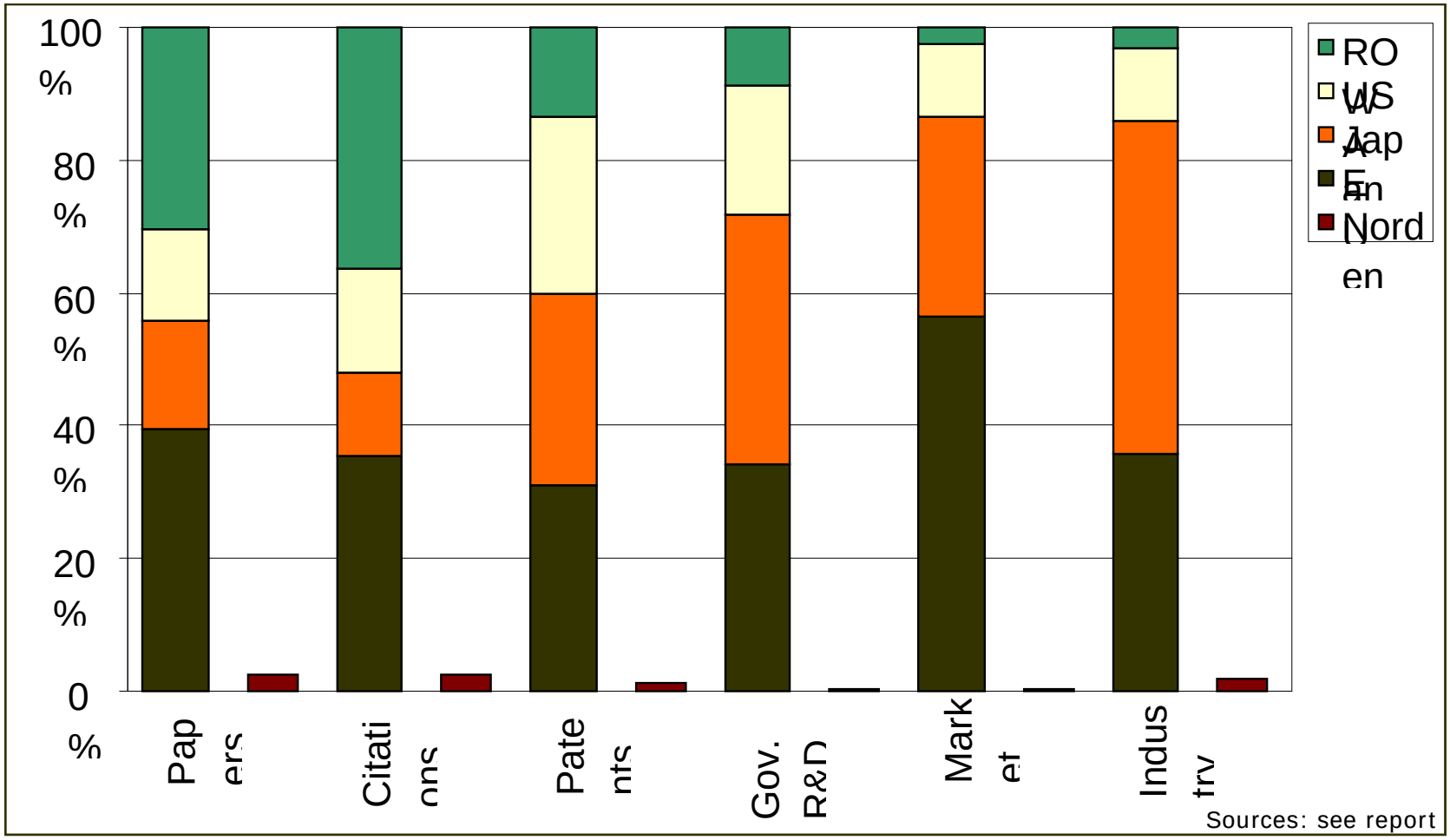
- Energy policy has until now not built on innovation system insight
    - but analytical knowledge has started to be built up – use it!

- Nordic strongholds
  - Visible in the general picture of energy innovation on global level
  - Specific competences on a number of energy technologies
  - General level competences (cultural level; general innovation system)
      - synergies and interaction in the innovation systems

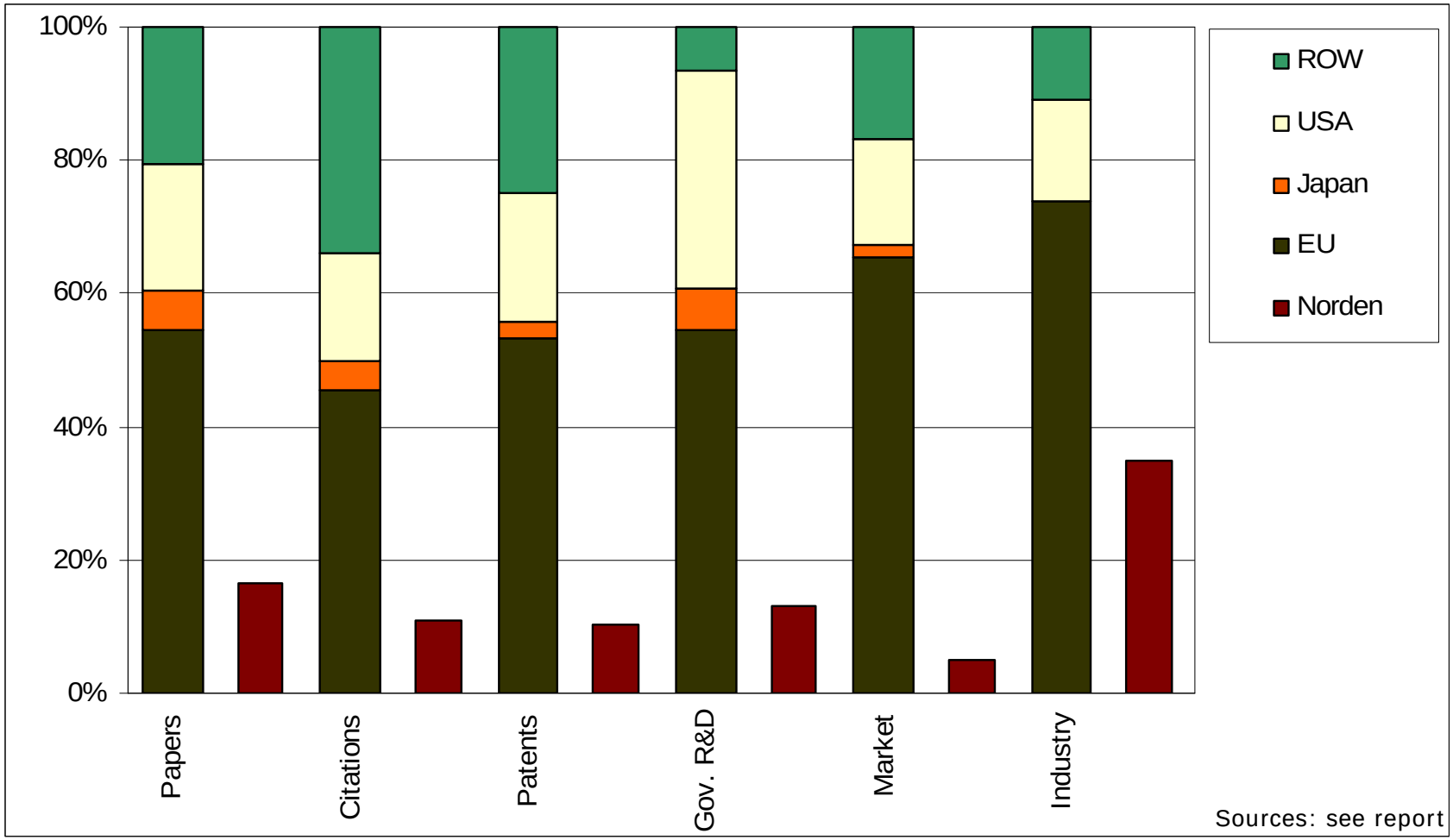
Nordic in the world: Biomass for heat & power

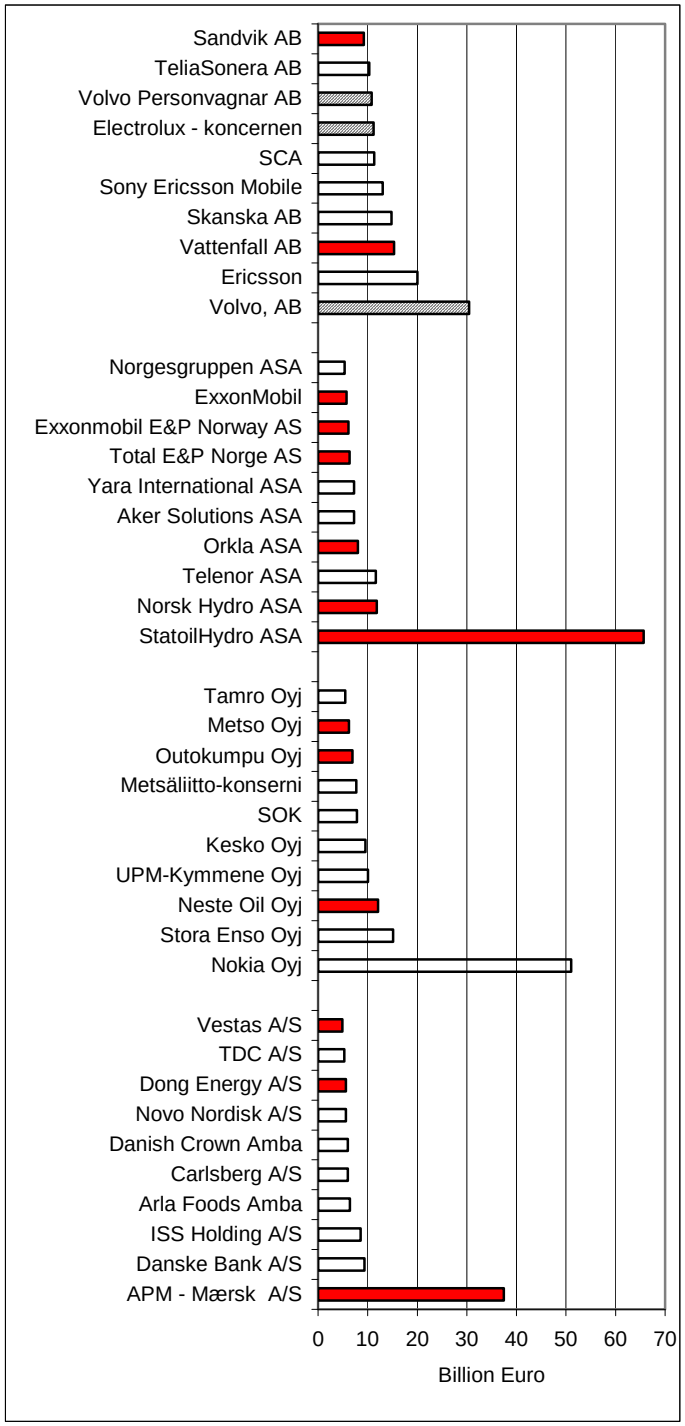


Nordic in the world: Solar cells



Nordic in the world: Wind energy





Energy technology: major industry area

Top–ten lists of largest companies in Sweden, Norway, Finland and Denmark

Red bars indicate energy related businesses

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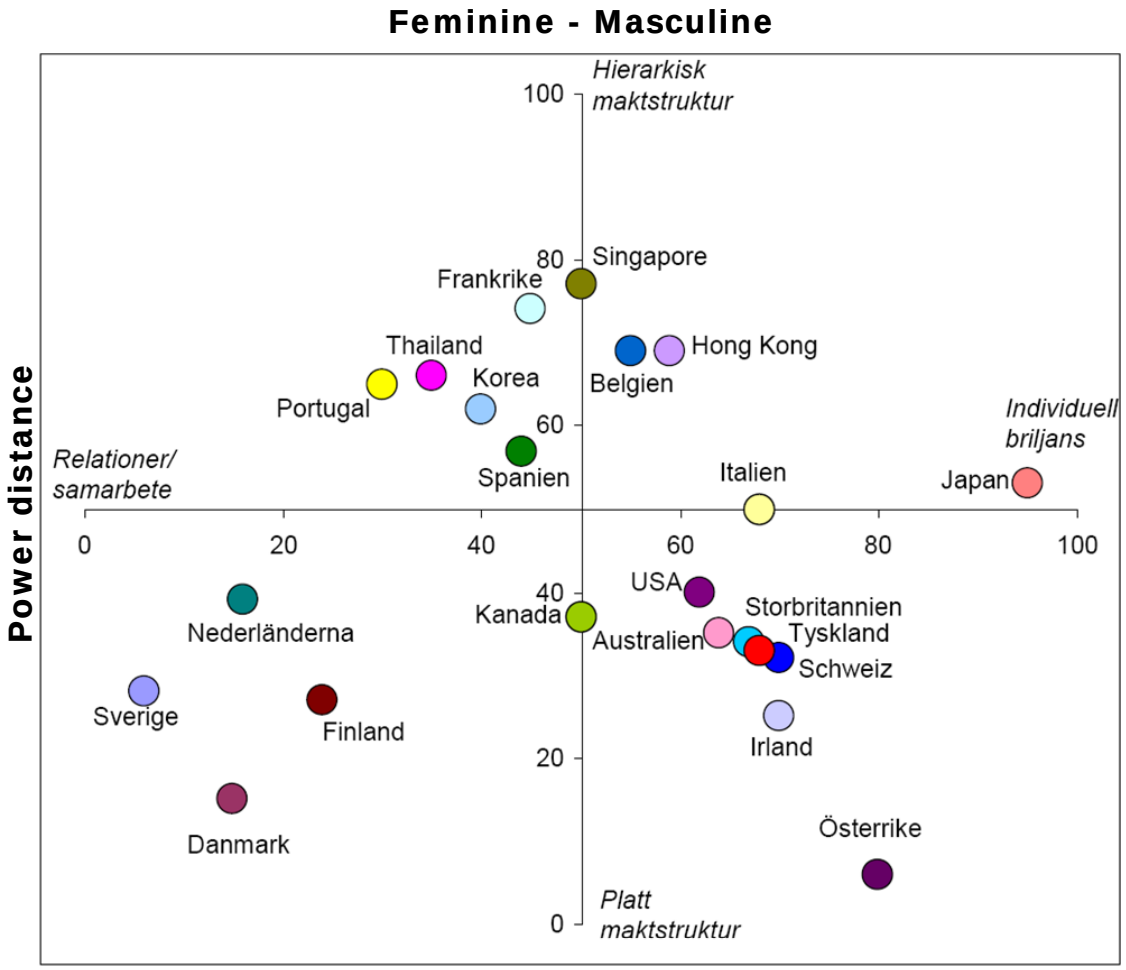
Cultural characteristics

Power distance and cooperative vs. individualistic culture ('femine' vs. 'masculine')



Source: Swentec 2007, IRIC (Geert Hofstede)

Need integration

Meeting between technological visions and potentials
and the actual needs and demands

Needs integration: The complex interaction between

Technology push ⟷ Demand pull

Three overall categories of processes:

- Integration by using (learning by using; user-driven innovation)
- Integration through public discussion and networks
- Integration through regulation and planning

Project objectives

Nordic Energy Innovation Systems

- Assess, compare, and make additions to the existing knowledge of the Nordic energy innovation systems

- Investigate patterns of cooperation and interaction
  - Dynamics of the energy innovation systems
    - Actors, networks
    - Learning types
  - Integrations between Needs and Technology potentials
  - Co-operation in public energy R&D programmes
- Investigate a number of indicators of innovation

- Contribute to the policy learning from the insight in the energy innovation systems

- New technologies/renewables: primarily Bioenergy, Solar cells, Hydrogen/FC and Wind

3 main results - I

1. **Significant diversity in the Nordic energy innovation systems**
   - between countries
   - between technology areas in the individual countries

No common Nordic energy innovation system

- (bioenergy to some extent an exception between Finland and Sweden, and broader)

Policy makers, ministries etc. should be aware of the variations and capable of taking the differences into consideration.

- Maintain a 'strategic intelligence' on the specific innovation systems and the individual technology areas

3 main results - II A

2. Energy innovation systems are typically closely connected to and anchored in existing industries and competence areas

Where we have seen strong industrial clusters emerging, this is clearly significant:

- Solar cells in Norway: electro-metallurgical industry (existing industry and new entrepreneurial companies) and natural resources (silicon)
- Bioenergy:
  - Finland and Sweden: wood industry, pulp & paper industry, CHP and district heating industries and machine industry (mostly Finland)
  - Denmark: agriculture, CHP/district heating, machine industry
  - Recent years: biotech industry and science
- Wind power in Denmark: Agriculture (organisation traditions); machine industry

3 main results - II B

- Lessons for policy makers:
  - New innovation systems and new technologies do not develop from scratch; grow from existing
  - Longer lasting, complex, historical developments
- Important for policy makers to have awareness of the competence bases and to identify new opportunities from that

- Different dimensions of existing bases:
  - Natural resources
  - Industrial bases
  - Existing energy systems / energy regimes
    - Both barrier and resource – spaces for development needed

3 main results - III

3. Learning-by-doing / integration of needs through application is a type of knowledge creation that is of significant importance and widespread in the Nordic energy innovation systems

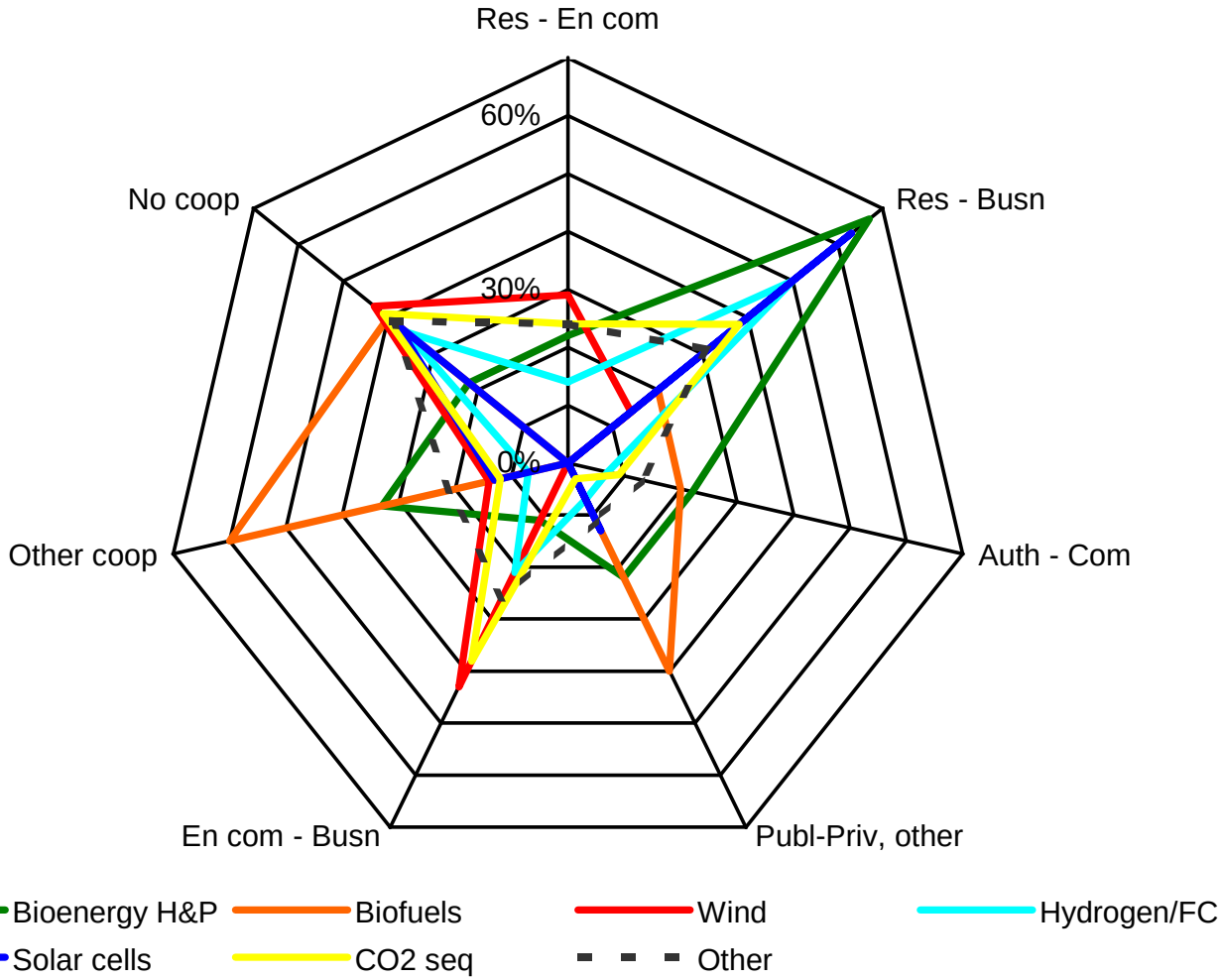
Most energy technologies – Fuel cell development an exception

Nordic countries have excellent and well-developed competences in use-driven innovation.

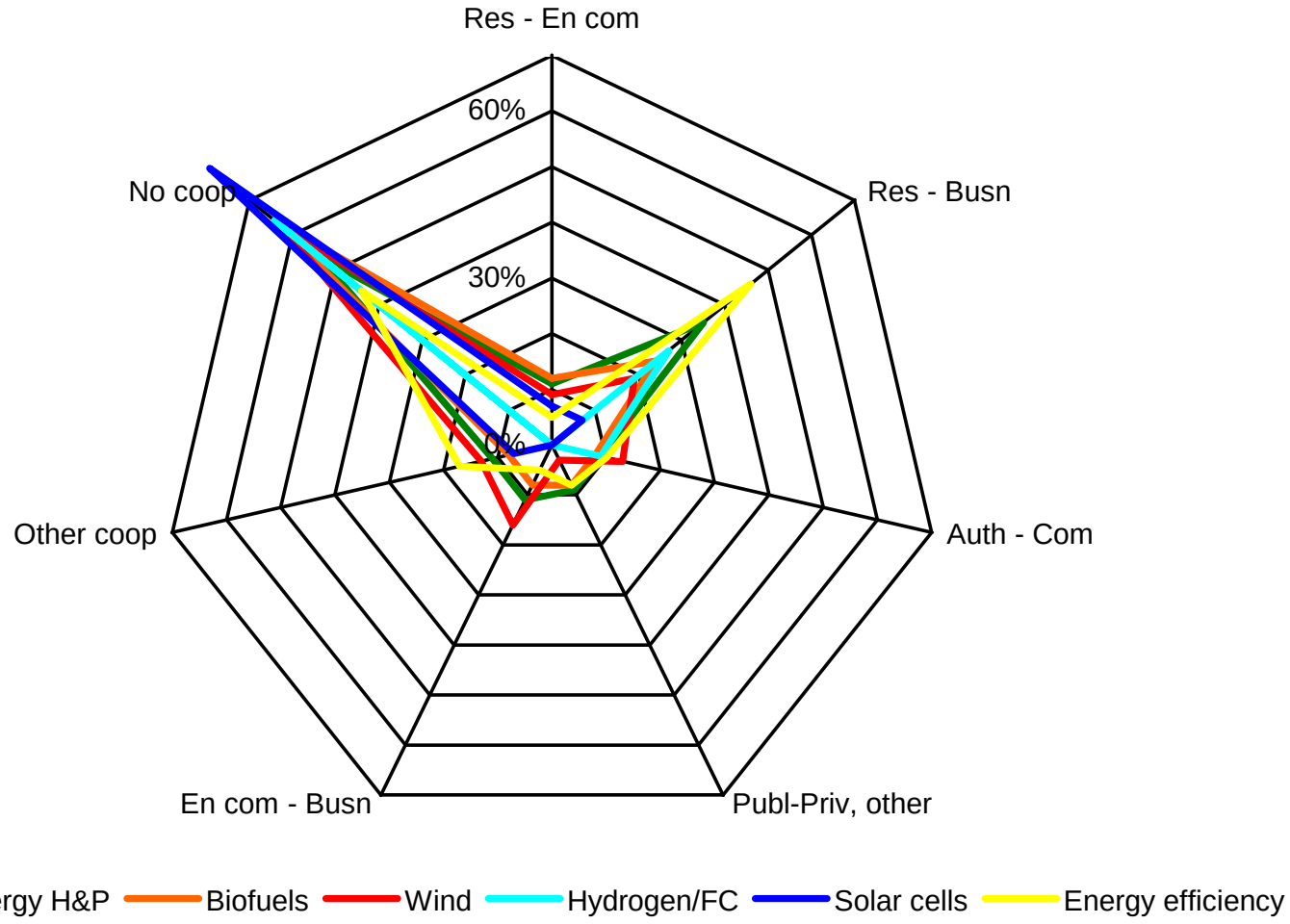
The Policy lesson is to consciously employ learning-by-using / learning-by-doing in the innovation and energy policies in a strategic way.

- Do not only focus on learning through formalised and academic knowledge production, but make learning-by-using/learning-by-doing and formalised knowledge production support and enforce each other.

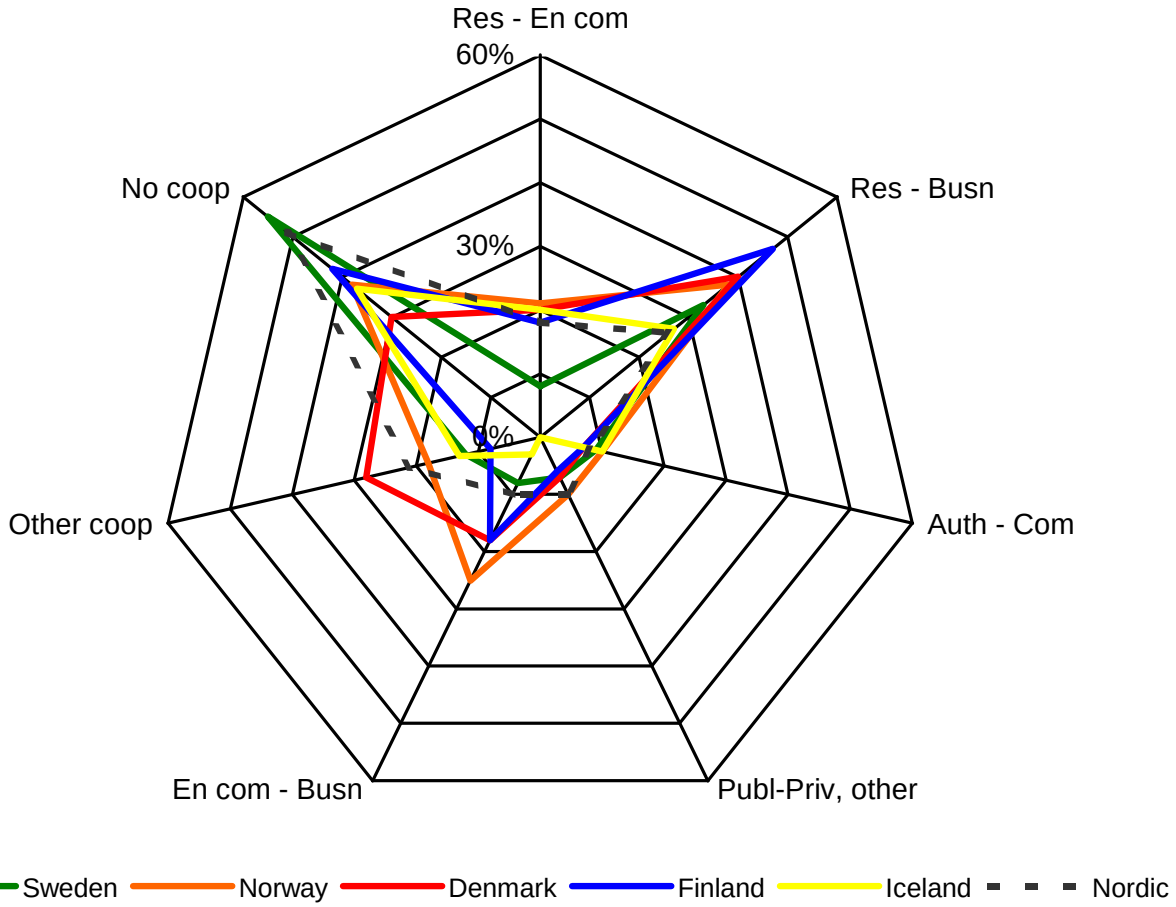
Cooperation patterns in R&D programmes - Norway



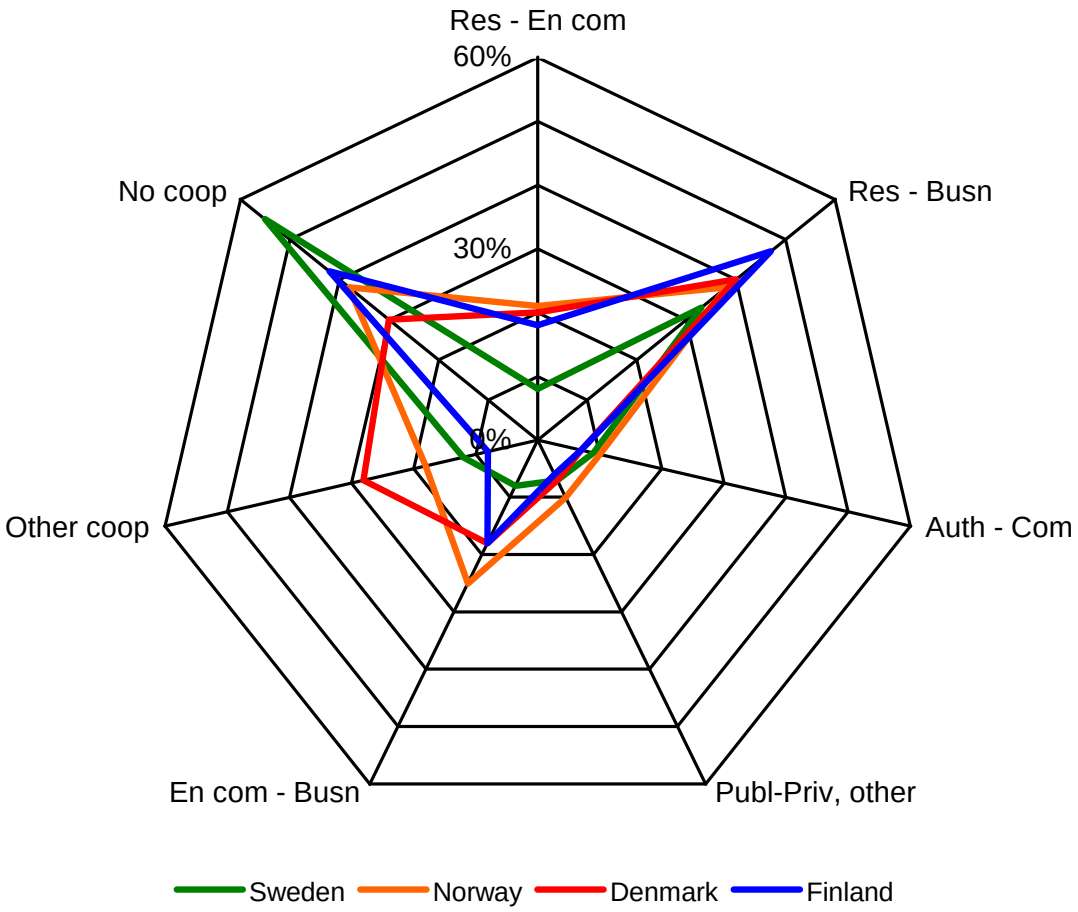
Cooperation patterns in R&D programmes - Sweden



Cooperation patterns in R&D programmes



Cooperation patterns in R&D programmes



Opportunities for joint Nordic initiatives? I

- **Nordic bioenergy cluster and export of bioenergy technology**
  - Relatively well-established innovation system
  - World leading positions on application and knowledge production
  - Considerable networks between Nordic countries
  - Can be developed towards an actual industrial cluster of international strength.
  - Requires a stronger emphasis on business development, industrialisation and export of bioenergy technology than until now.
  - Two legs:
    - Identification of export markets and exploration of export opportunities.
    - Continued networking and information exchange about industrial competences, application experiences and potentials of new and advanced areas of scientific knowledge in connection with bioenergy.
- **Gasification of biomass**
  - Nordic countries have built up considerable stock of knowledge and practical experience on gasification technologies for biomass
  - Leading competences on a number of points, both concerning gasification of materials based on wood and on materials from agriculture and farming
  - Networks in the Nordic countries already exist to an extent
  - Further support can lead to an industrial cluster with strong competitive advantages
  - Timing essential - clusters are being built up abroad (Germany and Austria)

Opportunities for joint Nordic initiatives? II

- **Integration of solar cells in construction industry and buildings.**
  - Domestic markets and the application side are relatively weak.
  - Yet, this is one of the most promising technologies in the longer term and the technology is currently being industrialised on a large scale in Germany.
  - The low integration in the construction industry and building traditions is one of the main gaps in the Nordic innovation systems.
  - A joint Nordic strategic effort for integration of solar cells in the construction industry and in building components may, therefore, be justified.

- **Nordic markets, networks and competences in the wind energy area.**
- Strong Danish wind turbine industry
- Important sub-supplier networks in the Nordic countries
- Support of new emerging competence areas within e.g.
  - offshore technology
  - turbine components

3 biggest challenges facing Nordic decision makers in the energy area the next decade?

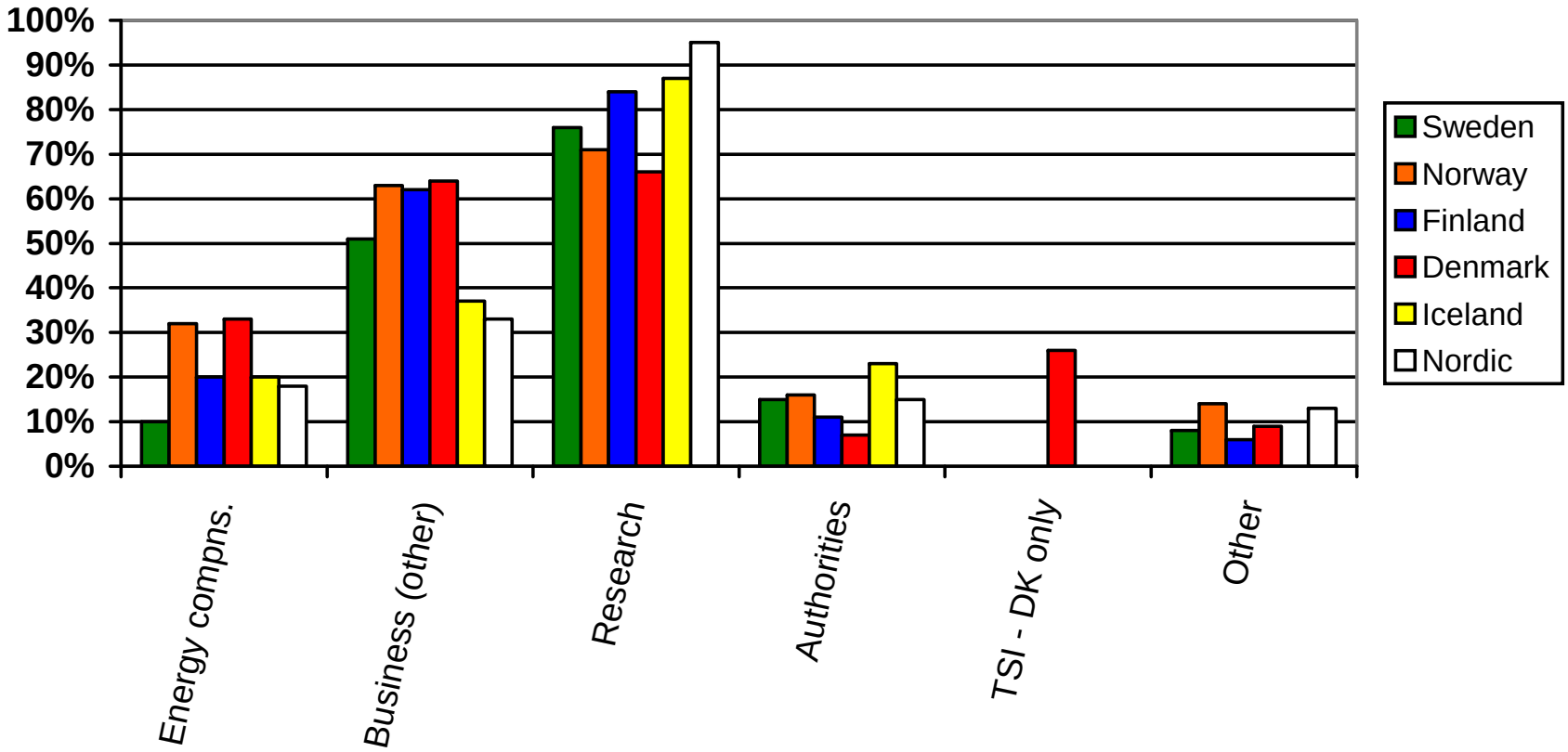
1. Climate and sustainability challenge
2. Competitiveness of Nordic energy technology industry
3. Transport sector: Reduction of energy use and emissions

What is needed to address these:

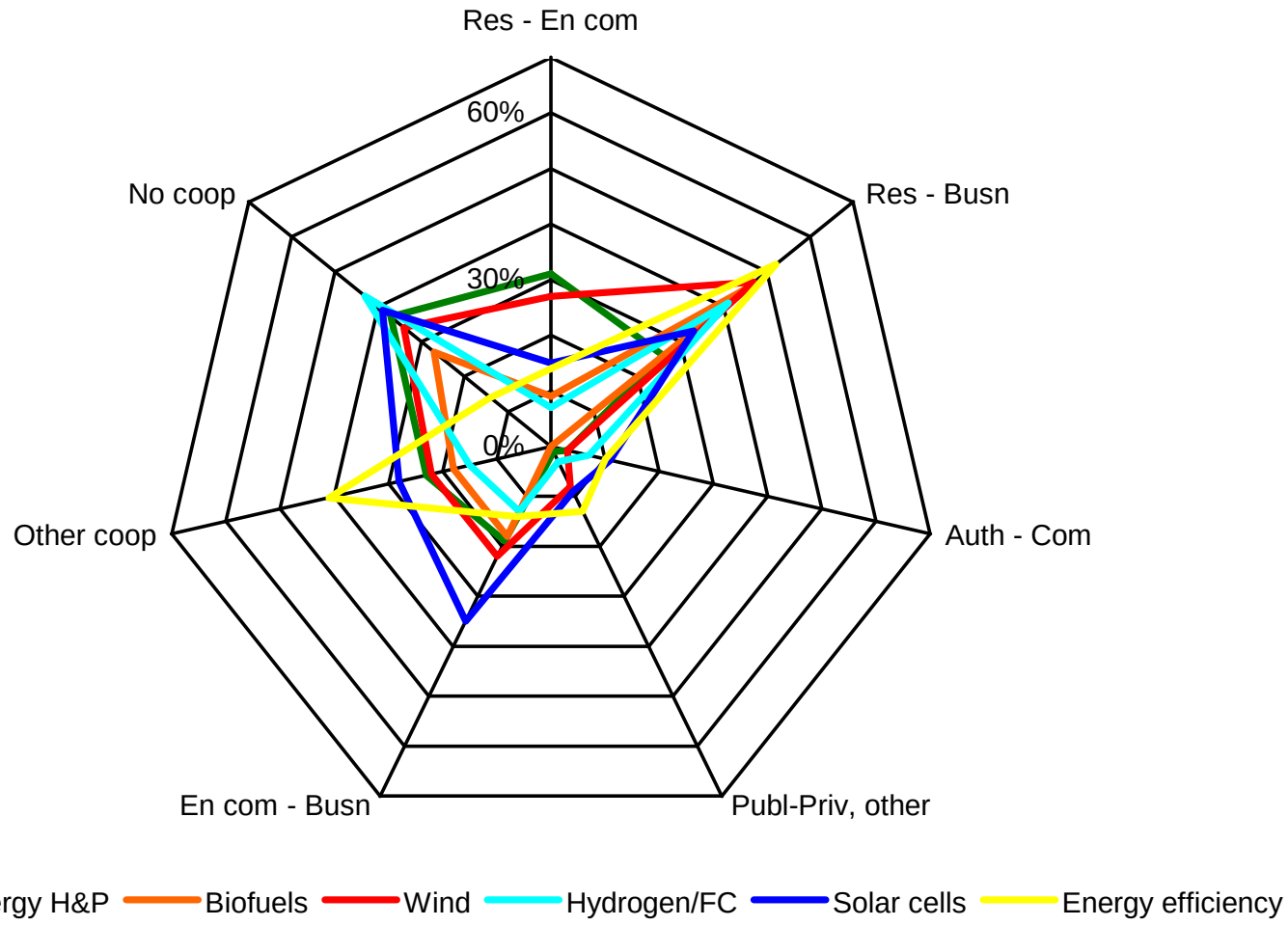
- Ambitious and innovation-driving requirements to the energy sector and the markets
- Support of experimentation and R&D
- Continued discussion and ambitious goal setting
- Be active, create lead competences and lead markets

Read the report!

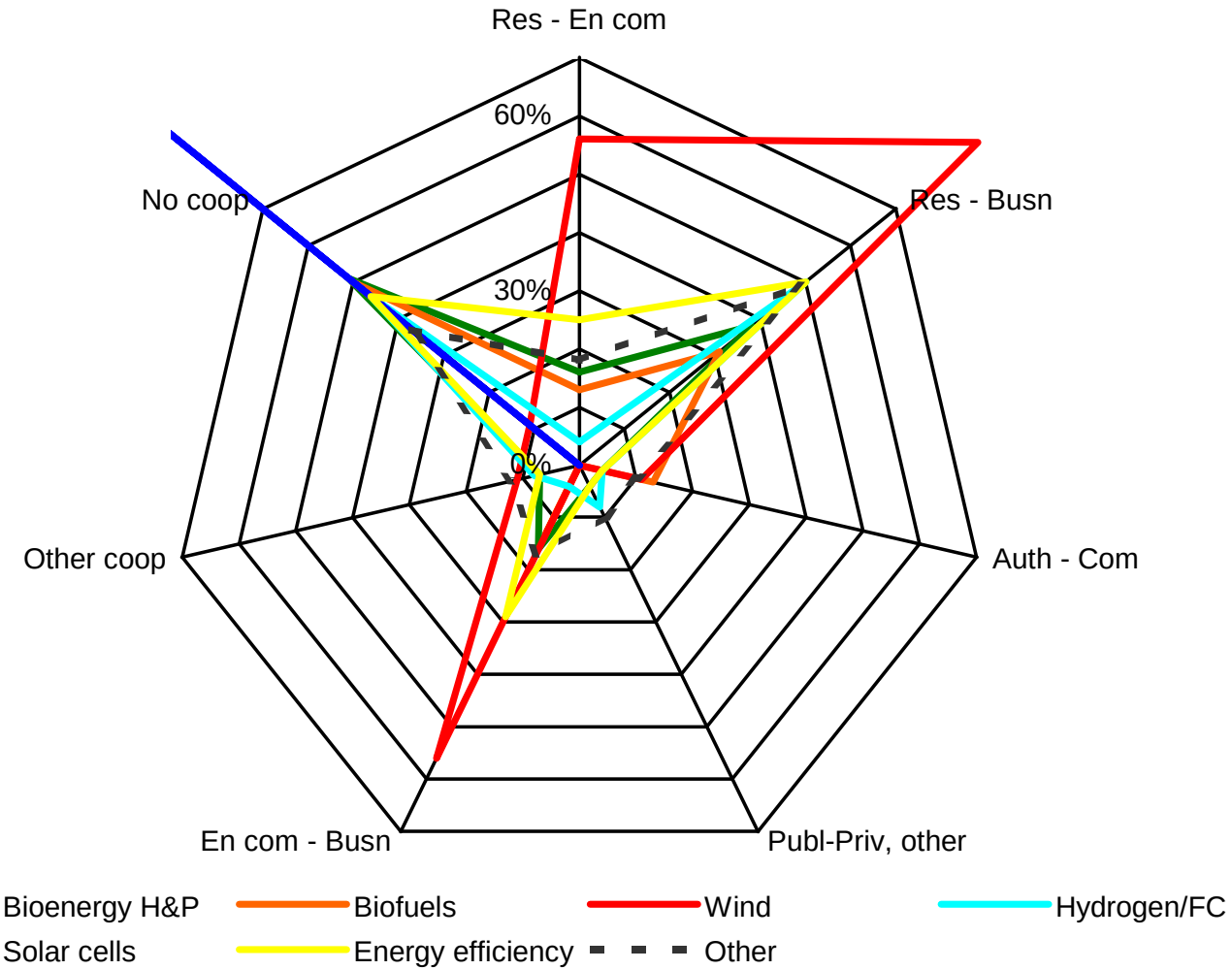
Participation in public R&D programmes - Actors



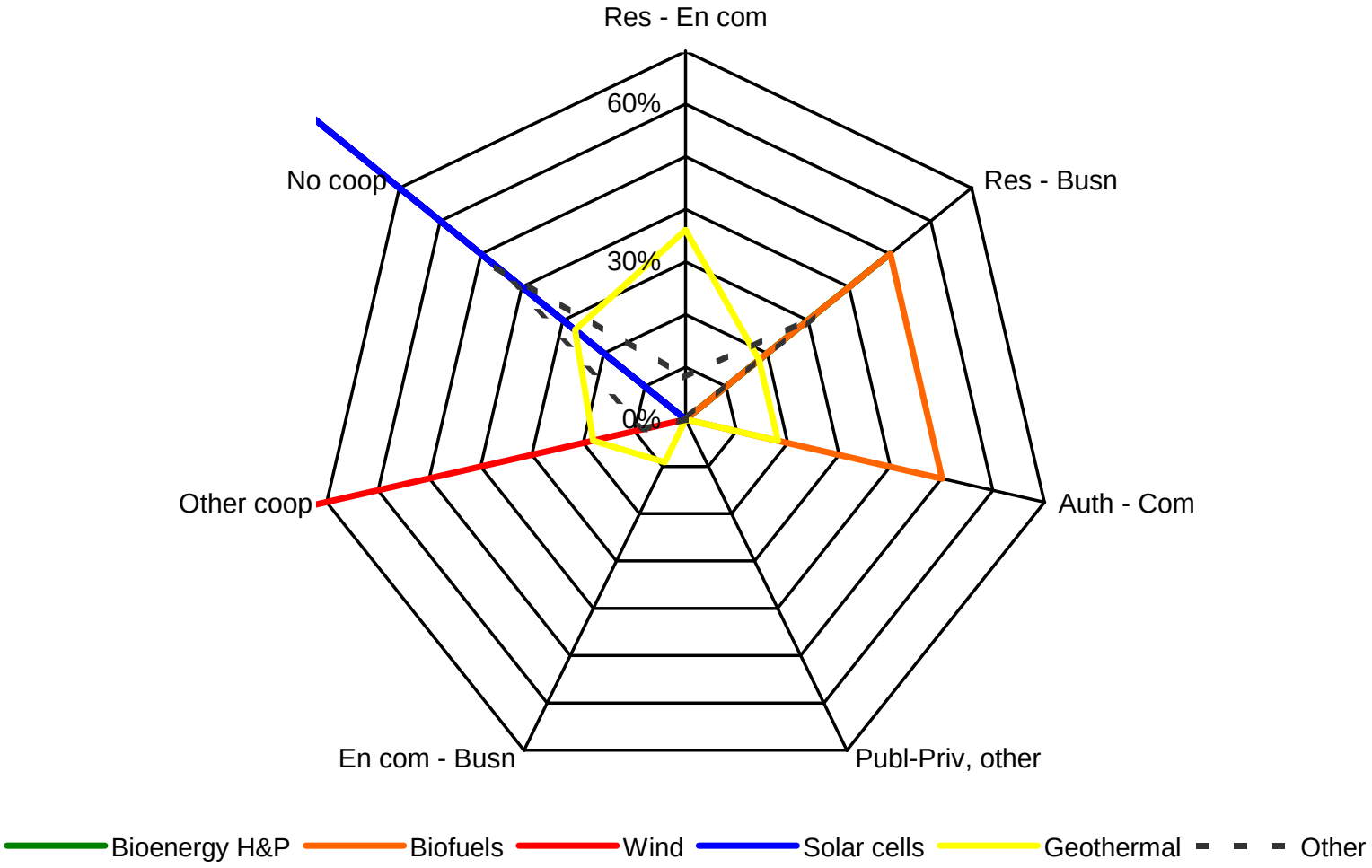
Cooperation patterns in R&D programmes - Denmark



Cooperation patterns in R&D programmes - Finland



Cooperation patterns in R&D programmes - Iceland



Need integration dynamics – 3 overall categories

	Learning by using	Broad discussion	Regulation
Norway			
Wind	0 (intn. sub-supply: +)	0	0
Solar cells	+ + intn. markets	0	0 (intn. markets: + +)
Bio energy	0	(+)	(+)
Hydrogen / fuel cells	+ + / 0	+ / +	+ / +
Small Hydro	+ +	+	(+)
Sweden			
Wind	+	% % %	+ (> 2005: + +)
Solar cells	(+) intn. markets	0	(+)
Bio energy	+ + +	%	+ +
Hydrogen / fuel cells	0	(+)	0
Denmark			
Wind	+ + +	+ + +	+ + +
Solar cells	(+) intn. markets	+ +	(+)
Bio energy	+ +	+	+ + +
Hydrogen / fuel cells	(+)	+ / 0	(+) / (+)
Finland			
Wind	0 (sub-supply: + +)	(+)	(+)
Solar cells	(+)	?	%
Bio energy	+ + +	+	+ +
Hydrogen / fuel cells	(+)	0?	(+)
Iceland			
Hydrogen / fuel cells	+	+ +	+